REMARKS

The present application was finally rejected based on various grounds in the Office Action mailed July 29, 2003. Subsequently, a telephone interview was held between applicants' attorney and the Examiner on October 7, 2003. Based on the interview, applicants have prepared the present amendment, which accompanies a Request for Continued Prosecution filed concurrently herewith. Claims 27-40 are pending in this application.

During the interview, the Examiner repeated his request that applicants more specifically point out the "correlation" between the data collected from embryos and the embryos' "quality." To meet this request, applicants submit the following. It should be understood that the following is provided merely to assist the Examiner's understanding of the present invention, and is note intended to limit the scope of the claims.

The present invention is directed to a method of classifying plant embryos according to their presumed quality, such as their potential to successfully germinate and grow into normal plants, based on spectral data obtained from the plant embryos. The method involves generally three steps. First, spectral data are obtained from reference plant embryos of known quality. In a simple case, the reference plant embryos of known quality are divided into two groups: those that are known to be of high quality, e.g., those that are likely to geminate and grow into normal plants; and those that are known to be of low quality, e.g., those that are unlikely to germinate and grow into normal plants. (Their quality is known based on a follow-up study or based on comparison with other zygotic embryos of known quality.) Thus, each spectral data set obtained from each reference plant embryo is correlated to the known quality of that reference plant embryo.

Second, one or more classification algorithms are applied to the spectral data sets, each being correlated to the known quality of the reference plant embryo from which the data set is

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obtained, to develop a classification model for classifying plant embryos according to their presumed quality. Essentially, a "classification model" (or a classifier) is a system that identifies an input by recognizing that the input is a member of one of a number of possible classes. Various classification algorithms are available to develop a classification model. (Some non-limiting examples are listed in the specification, at page 8, line 15 - page 9, line 8.) In one example described in the specification, at page 37, line 13 - page 38, line 10, an NIR (near infrared) spectroscopic setup was used to collect spectral data from a set of reference plant embryos of known quality, and the collected spectral data were subjected to principal component analysis. Principal component analysis, as well known in the classification art, involves a mathematical procedure that transforms a number of (possibly) correlated variables in the original data into a (smaller) number of uncorrelated variables called *principal components*. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. In other words, the first principal component is the projection on the direction in which the variance of the projection is maximized, and each succeeding component is the projection on the direction in which the remaining variance is maximized. Thus, principal components are "meaningful" variables, in the sense that they are highly indicative of the variance (leading to classification) of the data.

Referring back to the example in the specification, at page 38, line 11 – page 39, line 9, principal component analysis is applied to the spectral data collected from reference plant embryos using a software package "The Unscrambler" available from Camo ASA and its results are shown in FIGURE 2A. In this example, reference plant embryos were divided into four groups: Douglas-fir zygotic embryos of three different developmental stages (mature dry zygotics – noted as black circles in FIGURE 2A; "August 14" immature zygotics – white

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triangles; and "July 23" immature zygotics – black squares) and somatic embryos from Genotype 1 ("+" symbols). FIGURE 2A shows that these four populations of varying embryo quality can be separated into four clearly distinct groups when plotted with respect to the first three principal components obtained from the principal component analysis. In other words, the spectral data collected from the reference plant embryos and analyzed using principal component analysis are clearly "correlated" to the four populations of varying quality. Thus, these results are used to form a classification model to classify a plant embryo of unknown embryo quality. This is the third step of the present method. For example, when spectral data are obtained from a plant embryo of unknown quality (i.e., a plant embryo belonging to one of the four populations in this example), these first three principal components are calculated from the spectral data and are plotted in FIGURE 2A. Depending on where these three principal components are plotted in FIGURE 2A, the plant embryo of unknown quality, from which the spectral data are obtained, can be classified into one of these four populations of varying embryo quality.

Of course, this is merely one example of a classification model, which could be developed in accordance with the present invention. The specification provides other examples, at page 40, line 7 – page 45, line 14. In particular, FIGURE 4A shows two groups of embryos of high-quality appearance ("+") and low-quality appearance (black circles) plotted with respect to the first three principal components, and FIGURE 5A shows two groups of embryos of high-quality morphology ("+") and low-quality morphology (black circles), again plotted with respect to the first three principal components. "These results demonstrate that principal component analysis of spectral data from somatic embryos having high- and low-quality morphological appearance provides a basis for developing a classification model that will allow somatic embryos to be rapidly categorized with regards to their germination potential." (Specification, page 42, lines 19-23.) In other words, using principal component analysis, spectral data from

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embryos of known quality can be "correlated" to their quality, and the correlation is used to build a classification model for classifying embryos of unknown quality based on the spectral data obtained from those embryos of unknown quality.

It should be understood that principal component analysis is merely one example of a classification algorithm that can be applied to spectral data obtained from plant embryos to develop a classification model, and one or more of any other classification algorithms may be used instead.

1. Written Description Issue Under Section 112, First Paragraph

The final Office Action rejected Claims 27-40 of the present application under Section 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. The Office noted that "there is no clear correlation drawn between the data collected and compared and the 'quality' of an embryo." Based on the discussion above, applicants believe that the correlation between the collected data and the "quality" of an embryo was clearly drawn in the specification as filed. In particular, the specification includes concrete examples of the claimed method in the application, at page 38, line 3 through page 45, line 14, in detail, in reference to FIGURES 2A - 8B. These examples each graphically shows how a classification model was developed using the well-known principal component analysis, as applied to the spectral raw data obtained from plant embryos, to classify embryos into different groups of different quality. Accordingly, the application clearly shows that the inventors had a full position of the claimed invention at the time the application was filed.

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2. Indefiniteness Issue Under 35 U.S.C. § 112, Second Paragraph

The final Office Action further rejected Claims 27-40 under Section 112, second paragraph, as being indefinite. The Office noted that "there is no clear correlation drawn between the data collected and compared and the 'quality' of an embryo," and because no "correlation" is clearly established, "the invention is undefined." Based on the discussion above, applicants believe that the correlation between the collected data and the "quality" of an embryo was clearly drawn in the specification as filed, and thus the bounds of the invention as recited in amended Claim 27 is clearly defined. In this connection, applicants have replaced the term "embryo quality" previously used in the claims with "quantifiable characteristics." The word "quality" is defined in the specification at page 7, line 22 through page 8, line 2, as any value susceptible to quantification, including an embryo's geometric shape, size, surface texture, color, or capacity to germinate and grow into a normal plant, resistant to drought, resistant to pathogens, etc. Thus, while the meaning of the term "embryo quality" is believed to be sufficiently clear, in order to make it more clear that a classification model of the present invention is developed to classify plant embryos based on their certain "quantifiable characteristics", as opposed to being based on some vague notion of some embryos being more desirable over others, the previous term was replaced with a new term, throughout the pending claims. The amended claims are believed to clearly define the bounds of the present invention.

CLOSING

Based on the foregoing, Claims 27-40, as amended, are believed to be allowable. An early and favorable action allowing these claims and passing the present application for issuance

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is respectfully requested. If the Examiner should have further issues to resolve, he is invited to telephone applicants' undersigned attorney at the number set forth below.

Respectfully submitted,

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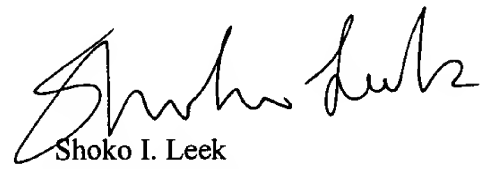

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